

Atlantidae (Pterotracheoidea) of the northeast Pacific

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Abstract

Atlantids are holoplanktonic snails found in epipelagic waters of all oceans mostly tropical and subtropical but some temperate. There are three genera within Atlantidae, which can be identified by a dextrally coiled, laterally flattened, transparent, discoid (*Atlanta*, *Protatlanta*) or involute (*Oxygyrus*) shell. They can be found in samples collected with plankton nets or sediment traps. Of the 23 species recognized worldwide, eight are known in the northeast Pacific. Herein distribution range extensions are reported for the atlantid species *Atlanta oligogyra* and *Protatlanta souleyeti*.

Key words: zooplankton, planktonic snails, heteropods, range extensions

Introduction

Atlantidae is the most diverse group within Pterotracheoidea (also known as heteropods). They spend their entire life cycle in the water column (holoplanktonic) and all species are epipelagic (0–~200 m depth). Most species have tropical or subtropical affinities since the group is more diverse in warmer waters (Lalli & Gilmer 1989). However, several species are also found in temperate waters up to ~45° N in the Pacific Ocean (McGowan 1967). Although Punta Eugenia, Baja California Peninsula, Mexico, is known to be a biogeographic boundary for several zooplanktonic groups, warm water atlantid species might be found north of this point in warm seasons or due to temperature anomalies in the area (*i.e.*, El Niño Southern Oscillation) (Lavaniegos *et al.* 2003, Aceves–Medina *et al.* 2018). For descriptions of warm water species not listed here, see Seapy (1990). The abundance of organisms within species varies with time of day, depth of sampling, season, and latitude amongst some variables (Wall-Palmer *et al.* 2016). While there are a few studies documenting the presence of atlantids in the northeast Pacific, mainly in the California Current (McGowan 1967, Seapy & Richter 1993, Cummings & Seapy 2009), there are none that show how the distribution and abundance of atlantids varies seasonally and/or latitudinally.

There are 23 species of atlantids described worldwide (Wall-Palmer *et al.* 2016). Seven of them have been recorded in the northeast Pacific (McGowan 1967, Seapy & Richter 1993, Cummings & Seapy 2009). However, there is genetic evidence that the species diversity worldwide is underestimated (Wall-Palmer *et al.* 2018).

Atlantids can be collected alive with plankton nets or dead (as empty shells) in sediment samples. Shells of these organisms from plankton samples or Recent sediments are commonly transparent, and therefore, if present, soft body parts can be seen. If collected specimens have contact with formalin or are old, shells become opaque and whitish.

Due to similarities in shell morphology, groups of species have been proposed for a more accurate determination. Grouping structures and body parts other than the shell can be found in Van der Spoel (1976, 1996) and Richter & Seapy (1999). In this work, species with the same number of whorls in the protoconch and/or with the same protoconch form are put together for ease of determination.

Material and Methods

Specimens analyzed belonged to 22 lots from the Smithsonian Institution, National Museum of Natural History (USNM), and 41 lots from the McGowan collection at Scripps Institution of Oceanography (SIO). A total of 182 samples were sorted with a spatial coverage from north Vancouver Island, Canada (~50°N), to Punta Eugenia, Mexico (~27°N). Of those, 29 samples belonged to cruise BIPOCO 1407 from Instituto Politécnico Nacional – Centro Interdisciplinario de Ciencias Marinas (IPN–CICIMAR) (~27–30°N); 38 from cruise SAKE 1207 (~35–50°N), 69 from cruise CCES 0807 (~34–44°N), and 46 from cruise CALCOFI 0808 (~30–34°N) from SIO. Zooplankton samples from oceanographic cruises SAKE 1207, CCES 0807 and CALCOFI 0808 were obtained by oblique tows with bongo nets of 505 µm net mesh at a maximum depth of 210 m up to the surface or 15 m above the bottom when depth was less than 210 m. Samples from cruise BIPOCO 1407 were taken by superficial tows with CALCOFI nets of 505 µm net mesh. All zooplankton samples analyzed were preserved in ethanol.

Repositories:

MNHN	Muséum national d'Histoire naturelle, Paris, France.
NHMUK	The Natural History Museum of the United Kingdom, London, UK.
RMNH	Naturalis Biodiversity Center, Leiden, The Netherlands.
SBMNH	Santa Barbara Museum of Natural History, California, USA.
ZMA	Zoological Museum Amsterdam, now in RMNH.

Systematics

Atlantidae Rang, 1829

(Figure 1A–C)

Diagnosis. Shell 0.5–12 mm, dextrally coiled, laterally flattened, transparent, discoid (*Atlanta*, *Protatlanta*) or involute (*Oxygyrus*); protoconch sculpture variable including smooth; body whorl calcified (*Atlanta*, *Protatlanta*) or of conchiolin (*Oxygyrus*); keel calcified (*Atlanta*) or of conchiolin (*Protatlanta*, *Oxygyrus*). Color variable. For radula, anatomical and whorl counting details see Seapy (1990).

Atlanta Lesueur, 1817: discoid, calcified shell and keel, body whorl with slit.

Protatlanta Tesch, 1908: discoid calcified shell, conchiolin keel, body whorl without slit.

Oxygyrus Benson, 1835: involute, calcified protoconch, conchiolin body whorl and keel.

Atlanta Lesueur, 1817

(Figure 1A)

Atlanta Lesueur, 1817: 390. Type species (SD Blainville 1825) *Atlanta peronii* Lesueur, 1817. Atlantic Ocean.

Steira Eschscholtz, 1825: 734. Type species (M) *Steira lamanoni* Eschscholtz, 1825. Baltic Sea.

Ladas Cantraine, 1841: 37. Type species (M) *Ladas keraudrenii* Cantraine, 1841. Mediterranean.

Diagnosis. Shell 0.5–12 mm; discoid; shell calcified; protoconch trochiform; body whorl with peripheral slit; keel calcified, consisting of two lamellae.

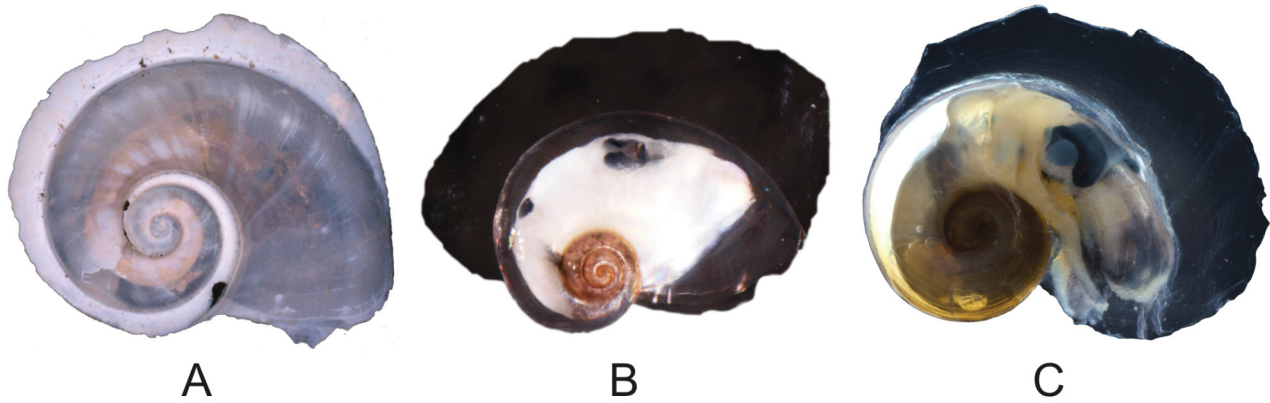


FIGURE 1. Atlantidae. A. *Atlanta peronii* Lesueur, 1817. 2690 fms, North Pacific Ocean, 35°9'57"N -137°47'W. (USNM 110736). B. *Protatlanta souleyeti* (Smith, 1888). 0–186 m, off Baja California Peninsula, Mexico, 26°17'16"N -119°47'53"W. (IPN–CICIMAR BIPOCO1509 sta. 116.7–105) C. *Oxygyrus inflatus* Benson, 1835. 0–200 m, Malpelo Island, Colombia, 3°58'22"N -81°36'25"W (IPN–CICIMAR Malpelo sta. MS–DIU).

***Atlanta lesueurii* Gray, 1850**

(Figure 2A–B)

Atlanta lesueurii Souleyet, 1852: 380, Eydoux & Souleyet 1841: pl. 20, figs 1–8. Lectotype MNHN–IM–2000–32717: Van der Spoel 1976. Atlantic Ocean.

Diagnosis. Shell to 6.0 mm, colorless, smooth; protoconch of 2½ whorls, without ornamentation; spire slightly elevated, profile trochiform, whorls easily distinguished; suture deep; keel tall, leading edge truncate, penetrating between third and fourth whorls.

Distribution. Cosmopolitan in tropical to subtropical waters, to ~35°N in the east Pacific. Uncommon.

***Atlanta oligogyra* Tesch, 1906**

(Figure 2C–D)

Atlanta oligogyra Tesch, 1906: 54, pl. 8, figs 14–18. Lectotype ZMA.MOLL.137660: Van der Spoel 1976. South Lucipara Island, Indonesia.

Diagnosis. Shell to 3.0 mm, smooth; protoconch of 2½ whorls, without ornamentation; spire low, profile rounded, first whorls forming dome; suture shallow, violet; keel tall, rounded, base violet, penetrating between third and fourth whorls.

Distribution. Cosmopolitan in tropical to subtropical waters, to ~31°N in the Pacific. Common to abundant.

Remarks. The northernmost records in the east Pacific for this species before this study was in the Gulf of Tehuantepec (Moreno-Alcántara *et al.* 2014) and Gulf of California (Angulo-Campillo *et al.* 2011), Mexico. In this study *A. oligogyra* was observed at ~31°N (IPN–CICIMAR, BIPOCO1407 sta. 103.3.40; 30° 46' 51.5634"N, 117° 4' 40.8"W), however records from McGowan (1967) of *A. lesueurii* might include *A. oligogyra* as they were considered synonyms until Richter (1986) demonstrated that they were different.

***Atlanta californiensis* Seapy & Richter, 1993**

(Figure 2E)

Atlanta californiensis Seapy & Richter, 1993: 398, figs 1–11. Holotype SBMNH 140126. Santa Catalina Basin, California, USA, 33°03.4'N -118°24.7'W.

Diagnosis. Shell to 3.5 mm, smooth; protoconch of $3\frac{1}{4}$ whorls, without ornamentation; spire slightly elevated, profile rounded; sutures shallow, colorless; keel tall, leading edge truncated, base golden brown, rear portion undulated, penetrating between third and fourth whorls.

Distribution. Gulf of Tehuantepec, Mexico (15°N) to $\sim 43^{\circ}\text{N}$ in the east Pacific. Abundant.

Remarks. This species was thought to be restricted to the North Pacific Transition Zone; however it has been collected from the Gulf of California and southern Mexico. It is more abundant in higher latitudes, with only a few specimens collected south of the Gulf of California, Mexico (Moreno-Alcántara *et al.* 2014; A. Janssen pers. comm.).

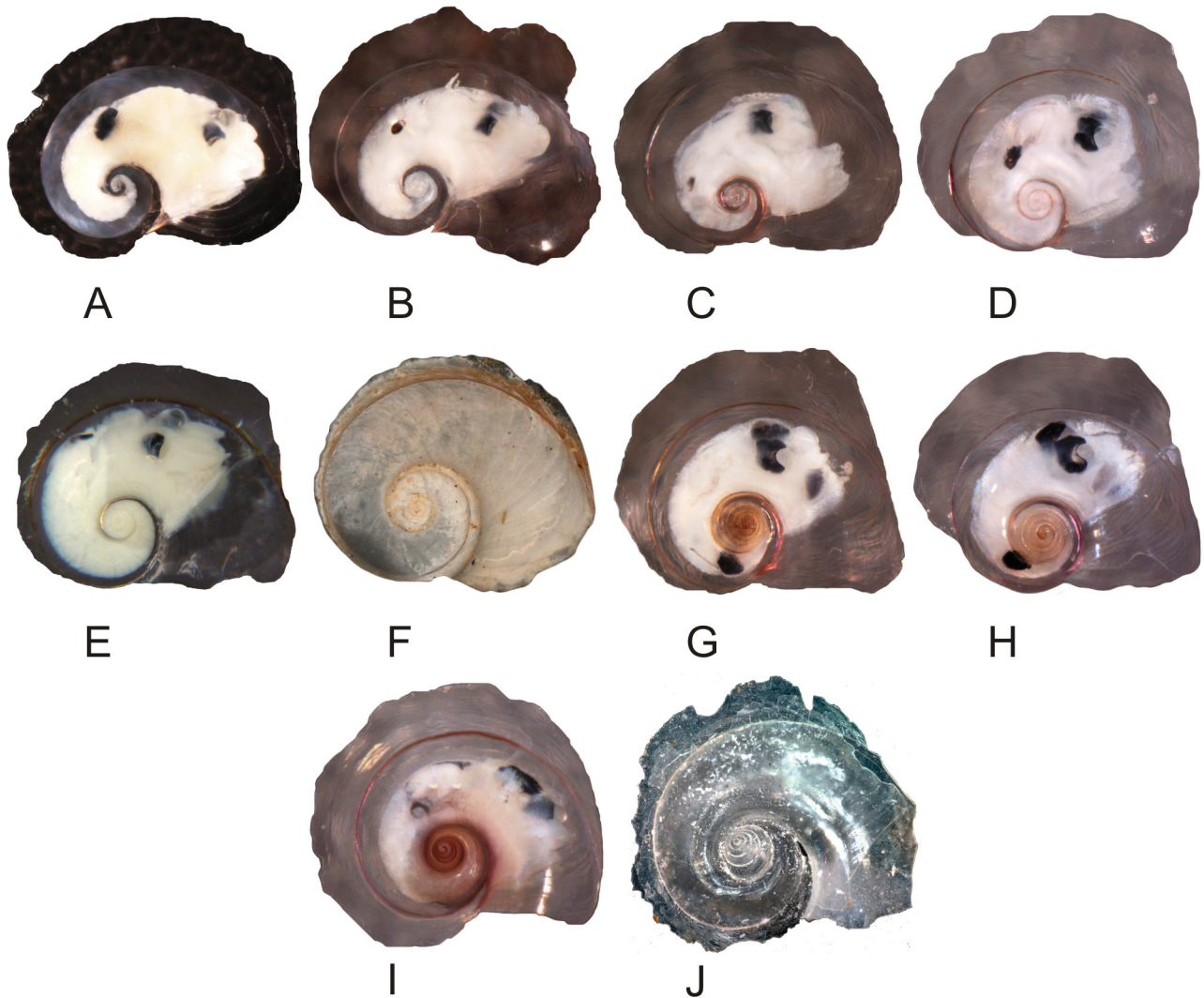


FIGURE 2. *Atlanta*. A–B. *Atlanta lesueurii* Gray, 1850. 0–91 m, off Baja California Peninsula, Mexico, $28^{\circ}17'40''\text{N}$ - $114^{\circ}52'26''\text{W}$ (IPN–CICIMAR BIPOCO1509 sta. 120–33). C. *Atlanta oligogyra* Tesch, 1906. 0–91 m, off Baja California Peninsula, Mexico, $28^{\circ}17'40''\text{N}$ - $114^{\circ}52'26''\text{W}$. (IPN–CICIMAR BIPOCO1509 sta. 120–33). D. *Atlanta oligogyra* Tesch, 1906. 0–205 m, off Baja California Peninsula, Mexico, $27^{\circ}2'29''\text{N}$ - $116^{\circ}49'55''\text{W}$. (IPN–CICIMAR BIPOCO1509 sta. 120–65). E. *Atlanta californiensis* Seapy & Richter, 1993. 0–211 m, off San Diego, California, USA, $31^{\circ}24'57''\text{N}$ - $122^{\circ}0'0''\text{W}$. (PIC–SIO CALCOFI0808 sta. 120–33). F. *Atlanta peronii* Lesueur, 1817. North Pacific Ocean (USNM 335240). G. *Atlanta inflata* Gray, 1850. 0–91 m, off Baja California Peninsula, Mexico, $28^{\circ}17'40''\text{N}$ - $114^{\circ}52'26''\text{W}$. (IPN–CICIMAR BIPOCO1509 sta. 120–33). H. *Atlanta inflata* Gray, 1850. 0–186 m, off Baja California Peninsula, Mexico, $26^{\circ}17'16''\text{N}$ - $119^{\circ}47'53''\text{W}$. (IPN–CICIMAR BIPOCO1509 sta. 116.7–105). I. *Atlanta turriculata* d'Orbigny, 1836. 0–205 m, off Baja California Peninsula, Mexico, $27^{\circ}2'29''\text{N}$ - $116^{\circ}49'55''\text{W}$ (IPN–CICIMAR BIPOCO1509 sta. 120–65). J. *Atlanta inclinata* Gray, 1850. 8–15 m, San Francisco Island, Gulf of California, Mexico (USNM 556267).

***Atlanta peronii* Lesueur, 1817**

(Figures 1A, 2F)

Atlanta peronii Lesueur, 1817: 390, pl. 2, fig. 1. Lectotype MNHN-IM-2000-32713: Van der Spoel, 1976. Atlantic Ocean.

Atlanta keraudrenii Lesueur, 1817: 391, pl. 2, fig. 1. Neotype RMNH.MOL.112446: Janssen 2012. SE of Lanzarote, Canary Islands.

Steira lamanoni Eschscholtz, 1825: 735, fig. 3. Iconolectotype Lamanon, 1797, pl. 63 figs 1–4: designated by Janssen (2012). Pacific Ocean.

Atlanta costae Mandralisca, 1840: 148, fig. 1. Syntypes: ?; Salvatore Beach, Messina, Sicily, Italy.

Ladas planorboides Forbes, 1844: 186. Syntypes: ?; Aegean Sea.

Atlanta steindachneri Oberwimmer, 1898: 587, figs 1–2. Syntypes: ?; Eastern Mediterranean.

Diagnosis. Shell to 1.2 mm, smooth; protoconch of $3\frac{1}{4}$ – $3\frac{1}{2}$ whorls, without ornamentation; spire slightly elevated, profile trochiform; suture deep, violet or golden brown; keel tall, leading edge truncated, base golden brown, penetrating between fourth and fifth whorls.

Distribution. Cosmopolitan in tropical to subtropical waters, to $\sim 43^{\circ}\text{N}$ in the Pacific. Uncommon.

***Atlanta inflata* Gray, 1850**

(Figure 2G–H)

Atlanta inflata Gray, 1850: 101, pl. 241, fig. 3, copied from Eydoux & Souleyet 1841: pl. 19, figs. 21–28. Lectotype NHMUK 1854.7.24.69 designated by Van der Spoel (1976). China Sea.

Atlanta inflata Souleyet, 1852: 378.

Atlanta quoyana Souleyet, 1852: 383, Eydoux & Souleyet, 1841: pl. 20, figs 16–22. Syntypes lost. Pacific Ocean.

Atlanta quoyii Gray, 1850: 110, pl. 242, fig. 1, Eydoux & Souleyet 1841: pl. 20, figs 16–22. Same types as *A. quoyana* (objective synonym). Pacific Ocean.

Diagnosis. Shell to 1.5 mm; protoconch of $4\frac{1}{4}$ – $4\frac{1}{2}$ whorls, brown, golden brown or violet, with sculpture of spiral ridges weak to prominent; spire low, profile trochiform depressed; sutures shallow; keel tall, leading edge truncated, base brown or golden brown.

Distribution. Pacific Ocean in tropical to subtropical waters, to $\sim 35^{\circ}\text{N}$ in the east Pacific. Common.

***Atlanta turriculata* d'Orbigny, 1836**

(Figure 2I)

Atlanta turriculata d'Orbigny 1836: 173, pl. 20, figs 5–11. Syntypes: lost. Atlantic Ocean.

Diagnosis. Shell to 2.0 mm; protoconch of $4\frac{1}{4}$ whorls, pink, golden or red brown, first three whorls narrow, strongly elevated, with sculpture of prominent spiral ridges; spire tall, profile turricular; sutures deep with raised edge; keel tall, leading edge rounded, base golden or red brown, penetrating between fourth and fifth whorl.

Distribution. Pacific and Indian Oceans in tropical to subtropical waters, to $\sim 34^{\circ}\text{N}$ in the east Pacific. Uncommon.

***Atlanta inclinata* Gray, 1850**

(Figure 2J)

Atlanta inclinata Gray, 1850: 101, pl. 241, fig. 1, copied from Eydoux & Souleyet 1841: pl. 19, figs 9–15. Lectotype MNHN-IM-2000-32715: Van der Spoel (1976). Atlantic Ocean.

Atlanta inclinata Souleyet, 1852: 275.

Atlanta affinis Tesch, 1906: 53, pl. 7, figs 9–10. Syntypes ZMA.MOLL.137654. South Lucipara Island, Indonesia.

Atlanta macrocarinata Bonnevie, 1920: 5, pl. 1, figs 10–13. Syntypes: ? $34^{\circ}44'\text{N}$, $47^{\circ}52'\text{W}$, North Atlantic Ocean.

Atlanta megalope Richter, 1961: 231, figs 4a, 13f, 21, 32. Syntypes: ?; Zanzibar.

Diagnosis. Shell to 7.0 mm, smooth, transparent to light yellow; protoconch of $4\frac{1}{2}$ –5 whorls; spire tall, tilted

in relation to spiral plane, profile conical; suture deep, clear to golden brown; body whorl overlapping on fourth whorl; keel tall, leading edge truncated to rounded, base golden brown, penetrating between fourth and fifth whorl.

Distribution. Cosmopolitan in tropical to subtropical waters, to ~34° N in the east Pacific. Uncommon.

***Protatlanta* Tesch, 1908**

(Figure 1B)

Protatlanta Tesch, 1908: 43. Type species (M): *Atlanta souleyeti* Smith, 1888.

Diagnosis. Shell 0.5–2 mm, discoid; shell calcified; protoconch trochiform; body whorl without peripheral slit; keel of conchiolin.

***Protatlanta souleyeti* (Smith, 1888)**

(Figure 1B)

Atlanta souleyeti Smith, 1888: 43. Syntypes NHMUK 1888.8.17.111–117. Atlantic Ocean.

Atlanta lamanoni Souleyet, 1852: 371. Eydoux & Souleyet, 1841: pl. 18, figs 30–37. Syntypes ?; Atlantic Ocean.

Diagnosis. Shell to 2.0 mm; protoconch of three whorls, smooth, brown to orange; spire low, profile rounded; sutures deep, colorless to light yellow, brown or orange; keel tall, cartilaginous, leading edge rounded, base colorless.

Distribution. Cosmopolitan in tropical to subtropical waters, to ~46° N, in the east Pacific. Uncommon.

Remarks. The northernmost records in the east Pacific for this species before this study was in the Gulf of Tehuantepec (Moreno-Alcántara *et al.* 2014) and Gulf of California (Angulo-Campillo *et al.* 2011), Mexico. The specimen used to determine this range extension was recorded from off Oregon, USA (USNM 331110). Several specimens were observed in samples from off Baja California Peninsula (IPN-CICIMAR BIPOCO1407 cruise).

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